

Upscaling zero tillage in rice fallow lands of the Indo-Gangetic Plains: Some experiences

RK Gupta¹ and S Pande²

Introduction

South Asia is one of the major rice producing regions of the world, with about 50 million ha under its cultivation. Much of this area has a single crop per year, usually rainy season rice and no crop is grown after the rains. The Indo-Gangetic Plain (IGP) alone in South Asia occupies about 8 million ha under rice during the rainy season. Approximately, 2.5 million ha of rainfed rice land in IGP is left fallow. The large and growing population of the region especially in the IGP requires ever-increasing quantities of locally available food grains.

The large land areas that lie fallow with adequate moisture to grow a second crop for much of the year are particular cause of concern in IGP. Subbarao et al. (2001) estimated 14 million ha rice fallow lands in South Asia (Bangladesh, Nepal, Pakistan and India). However, these studies may under-represent the true total, because it failed to identify any rice fallow lands in Ballia district of Uttar Pradesh in India, and the current study identified nearly 17,000 ha of rice fallows in the same district. If this figure were to be added, the total area would stand at 36,904 ha (Fig. 1).

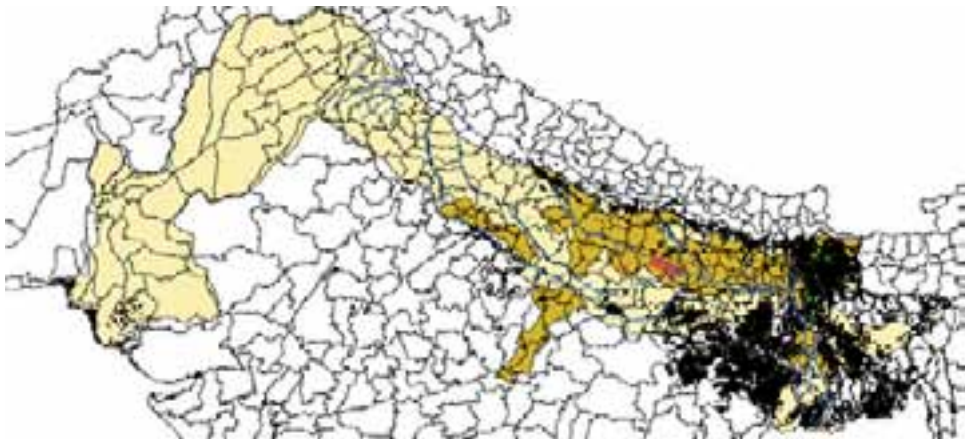


Fig. 1. Rice fallow lands in Ballia, UP.

¹Rice Wheat Consortium, CIMMYT-India, NAASC, DPS Marg Pusa Campus, New Delhi, India.

²International Crops Research Institute for the Semi-Arid Tropics, Patancheru, Andhra Pradesh, India.

Since rice is grown on some of the most productive lands, there is substantial scope to increase cropping intensity by introducing a second crop during the rabi season. Legumes such as chickpea, khesari, lentils, mung bean and black gram are potential crops for rice fallows. These crops may not require supplemental irrigation and contribute substantially to enriching soil fertility of these soils by fixing atmospheric nitrogen and adding organic matter. In addition, they may sustain the rice-based systems by breaking the disease and pest cycle associated with the sole cropping system. Similarly, they could enhance the microbiological activity and thereby nutrient availability of the soil following rice. Satellite image analysis estimates and GPS based survey were used in further identify and characterize rice fallows in Tal areas of eastern IGP that could be brought under targeted zero tillage technology for the establishment of second crop including legumes.

Soil characteristics of rice fallows

Rice fallows have fine textured soils with good water holding capacity. According to USDA Soil Taxonomy, these soils are broadly classified as alfisol, inceptisol, entisol and vertisol. These soils are generally fertile, and calcareous deep. They vary in texture from silt loam to silty clay loam, and are poorly and/or imperfectly drained. These soils often develop cracks at end of the rabi season indicating availability of moisture for supporting a short duration second crop on residual soil moisture. These soils have low to medium quantities of soil organic matter and medium to high soil fertility with adequate residual soil moisture. Table 1 gives the estimated soil fertility status of the tal lands.

Table 1. Soil fertility of soils in tal* lands.

Character	Rajpur tal (Bhagalpur)	Barahia tal (Begusarai)
PH	7.0-7.4	7.1-7.9
EC (dS/m)	0.30-0.40	0.20-0.43
Organic carbon (%)	0.25-0.63	0.22-0.92
Available P (kg P ₂ O ₅ /ha)	25.0-43.0	19.0-51.5
Available K (kg K ₂ O/ha)	144-432	300-1110
Available Zn (ppm)	0.48-5.64	0.35-4.09
Available Cu (ppm)	0.79-2.91	0.48-1.60
Available Mn (ppm)	29.3-166.4	3.2-6.4
Available Fe (ppm)	14.5-54.5	5.2-14.8

*Highly fertile soils due to fresh deposition of sediments; crop establishment practices in the tal lands need to be appropriate.

In low fertility soil, use of 100 kg DAP/ha has been found superior for pulses. Additionally use of borax @ 15 kg/ha for gram and Sulphur @ 20 kg/ha for lentils has been found to increase yield by 15-20%. Also NPK fertilizer use @ 80 : 40 : 20 per ha is appropriate for most crops. Use of Rhizobium in pulse production increases yield by 10-15%.

Major crops for rice fallow lands

Wheat, winter maize, Indian mustard and potato are the major crops wherever irrigation and winter rains are assured. However, under occasional rainfed situations, linseed with Indian mustard as a mixed crop is commonly cultivated. In this environment, chickpea and wheat as mixed crop are also common and grown traditionally. In certain areas under rainfed situations, chickpea and wheat mixed crop, chickpea and lentils as *paira* crop in/after the rice are grown as relay crop. In some areas where limited but assured supplemental irrigation is available, wheat and mustard are grown as sole crops.

Resource conservation technologies: Zero-tillage and surface seeding

Major causes for rainfed rice lands to remain fallow include lack of irrigation facilities, and rice vacating the fields late to permit planting of a second crop during the rabi season. Such situations are typical of *Tal*, *Chaur* and *Diara* lands. In many upland and midland areas, where there is no ground water development for irrigation, land also remains fallow. Rice fallow lands generally belong to poorer farmers who have no irrigation facilities.

In areas that lack irrigation facilities, timely seeding taps residual moisture of the previous rice crop. Relay cropping or surface seeding of cereals and legumes in particular could offer potentially good cost effective options for resource-poor farmers. Certainly, surface seeding has the potential to increase farm incomes. Residual soil moisture contents in these deep alluvial soils after rice are sufficient for taking short duration legumes such as lentils and chickpea. These crops not only increase crop diversification in the cropping system, but also contribute to soil fertility. It is observed that available and workable technological options were never reached to the eastern IGP to reduce rice fallows. Therefore, diffusion of knowledge about Resource Conservation Technologies (RCTs) is an appropriate option for the complex ecologies in eastern IGP in particular and similar environments elsewhere. It is believed that most rice fallows here could be put under crop production using surface seeding and zero till planting techniques (Chandana et al. 2004).

Some of our efforts in bringing rice fallows into double cropping are:

- Broadcasting (paira) cropping in poorly drained soils: lentils/chickpea.
- Zero-till planting of chickpea and lentils that are profitable in normal soils.
- Line sowing of lentils and chickpea 25 cm and 30 cm apart by using a ZT drill has been found superior to traditional practices.
- With the ZT drill, it is possible to reduce the seed rate of lentils and chickpea substantially by almost 50%.
- Inter-cropping of gram : wheat in 3:1 ratio in line-sown condition is better than mixed cropping.

Legumes and their cultivars for Eastern IGP

In the rice fallow cropping systems, several temporal and spatial variations in the relations of the two major crops of the system are observed. Rice and wheat may be grown: (i) in the same plot, (ii) in different plots during a year, and/or (iii) in same plot in different years.

While rice and wheat may be the main crops grown in the same plot, other crops such as maize, chickpea, mustard, mung bean, lentils, sesame, black gram, pigeonpea and potato are the major replacement crops. Legumes are known as risk management crops in the rice fallows (Pande and Gowda 2004). Recently, we found that among legumes, lentils cultivar Arun (PL77-12), which is resistant to yellow rust, stemphyllium blight and tolerant to low temperatures is the most suitable for RCT. Its seed rate with seed drill @ 30 kg/ha has been found more productive than the prevalent practice of 100-130 kg/ha. Similarly, chickpea cultivar RAU-52 and DHG 82-4 and field pea variety 80-60-5 were found suitable for RCT and rice fallows in eastern IGP. In tal lands, we have evaluated chickpea varieties following improved crop and pest management practices and found that with minimal inputs these varieties could give grain yield of 1.5-2 tons/ha (Table 2).

Table 2. Performance of chickpea cultivars in tal lands.

Variety	Yield (tonnes/ha)
SG 2	1.59
C 235	1.47
H 208	1.76
DHG-82-12	1.83
DHG-82-10	2.01
DHG 83-1	1.91
Pant G 114	1.40
Local	1.78

Enabling factors for up-scaling

Effective promotion of RCTs for underutilized lands including rice fallows will require a well-organized database of land information that includes distribution and extent of certain land types and areas with specific problems (eg, soil moisture shortage, excessive wetness, salt affected lands and flood events). Geographic information systems and remote sensing technologies provide unique tools for achieving this goal. They provide backstopping for upscaling agronomic practices in problem areas. Application of remote sensing can help gather important data for pre-planning diffusion and targeting strategies of RCTs. However, enabling factors for upscaling of any technology including RCTs in particular must:

- Be time-tested
- Be simple and affordable
- Be farmer friendly
- Identify the champions and involve stakeholders
- Engage critics

RCTs, IPM and legumes

In general, it is believed that legumes do not respond to management. However, extensive testing of various combinations reveals that in spite of apparent higher productivity, rice-wheat and rice-rice are as remunerative as rice-legumes combination. This combination was found to be economical and ecologically harmonious. The efficiency of this system however, depends on several factors including genotype of the legume, population density and integrated crop and pest management.

Four options are readily available for introducing legumes through RCTs in the rice fallows: 1) To include short duration varieties of legumes, 2) to substitute low yielding cultivars with high yielding cultivars, 3) to introduce improved agronomic practices, and 4) to introduce integrated pest management as an integral part of the crop management. While introducing legumes in the rice fallows, we followed these components:

- Seed treatment with fungicides like captan, thiram/carbendazim @ 2 g/kg seed or *Trichoderma viride* 4 g/kg seeds which gives protection from wilt and blight in pulses (damages 30-40% seedlings in initial growth stage).
- Chlorpyrifos @ 8-10 ml/kg seed, which has been found quite effective to control cutworm.
- Dusting of insecticide like malathion 5% @ 25 kg/ha.
- Spraying of monocrotophos @ 1 ml/liter, which is useful to control aphids that badly affect oil seed and lathyrus. Rust, wilt and stem rot are major diseases of lentils and gram. A spray of 2.5 kg Indofil M-45 in 100-liter water is recommended.

- Spraying 1.5 ml karathane or 3 g sulfex per liter of water to combat powdery mildew, a serious disease of pea.
- Use of Zero tillage machine for timely sowing of pulses and wheat, which has been found quite effective.

Conclusion

Adaptation of legumes in rice fallows provides a range of options. In the present scenario, legumes hold great promise for rice fallows as they are locally well adapted, need low input, sustain long term productivity of soil, besides being an important part of the local diet, culture and economy. Expansion of legumes into rice fallows will also need critical inputs such as seed, timely sowing and crop establishment, and crop and location specific IPM. Availability of critical inputs and easy credits, besides crop insurance and reasonable minimum support price are some of the policy issues, which can propel the farmers to grow legumes in rice fallows with minimum risk and profitability and thus help diversify the existing system.

References

- Chandana P, Hodson DP, Singh U, Singh AN, Gosain AK, Sahoo RN and Gupta RK.** 2004. Increasing the productivity of underutilized lands by targeting resource conserving technologies – A GIS/remote sensing approach: A case study of Ballia district of Uttar Pradesh in the Eastern Gangetic Plains. Mexico DF: CIMMYT. 43 pp.
- Pande S and Gowda CLL.** 2004. Role of legumes in poverty reduction in Asia: A synthesis. Pages 204-219 *in* Role of legumes in crop diversification and poverty reduction in Asia (Gowda CLL and Pande S, eds.). Proceedings of the joint CLAN Steering Committee Meeting, 10-12 November 2003, ICRISAT, India. Patancheru, Andhra Pradesh, India: ICRISAT. 234 pp.
- Subbarao GV, Kumar Rao JVDK, Kumar J, Johansen C, Deb UK, Ahmed I, Krishna Rao MV, Venkatratnam L, Hebber KR, Sai MVSR and Harris D.** 2001. Spatial distribution and quantification of rice-fallows in South Asia: Potential for legumes. Patancheru, Andhra Pradesh, India: ICRISAT. 316 pp.